Progress Summary

Project Progress : 54.00%

Budget Used : 43.72%

Human Capital :100.00%

Current Outcome

Type	Number
Activities	6
Publication	2
Exhibition	0
Intellectual Property	0
Product	0

Milestone

No.	Description	Project Completion Contribution	Expected Completion Date	Completed Percentage	Actual Completion Date	Contributed Progress
1	Completion of literature review	10	30/04/2016	100	30/04/2016	10.00%
2	Completion of nanopore-enhanced ZnO nanorod arrays synthesis	20	31/07/2016	100	25/07/2016	20.00%
3	Completion of seed layer deposition onto nanopore-enhanced ZnO nanorod arrays	10	31/10/2016	80		8.00%
4	Completion of hierarchically homogenous branched, nanopore-enhanced ZnO nanorod arrays fabrication	30	30/04/2017	30		9.00%
5	Completion of hierarchically homogenous branched, nanopore-enhanced ZnO nanorod arrays characterizations and photoresponse measurement	20	31/07/2017	10		2.00%
6	Completion of journal writing, report and documentation	10	31/10/2017	50		5.00%
Overall Progress						54.00%

Research Abstract

Novel hierarchical homogenous nanoarchitectures of branched, nanopore-enhanced nanorod arrays are promising nanostructures for nanosensors and solar cells due to their advantages; that are very high surface area, enhanced light absorbability, and multiple transportation channels of electron. These new nanostructures are anticipated to significantly improve nanodevice's performance in terms of sensitivity, reliability, and functionality. Conventionally, nanorod arrays or branched nanorods with disorder arrangement have been fabricated, but their characteristics (i.e., optical and electrical) and photoresponse properties were highly modulated by surface area availability and arrangement of nanostructures on the substrate. Hence, it is important to increase the surface area of well-arranged or well-aligned nanorod arrays, by tailoring their surface condition to be facilitated with hierarchical branches and nanopores. To the best of our knowledge, the development of hierarchically homogenous branched, nanoporeenhanced nanorod arrays has not been reported yet. The nanoscaled modifications on nanorod array structures, particularly with formation of nanorod branches and nanopores, will provide new insight into characteristics and photoresponse properties of the nanorod arrays. In this research, hierarchically homogenous branched, nanoporeenhanced zinc oxide (ZnO) nanorod arrays will be fabricated using sonochemical approaches. With variations of fabrication parameter, such as ultrasonic power and ultrasonic irradiation time, the photoresponse performance and characteristics (i.e., optical, structural, and electrical) of the prepared nanostructures will be thoroughly investigated. For the characterization purposes, field-emission scanning electron microscopy, transmission electron microscopy, atomic force microscopy, ultraviolet-visible-near-infrared spectroscopy, photoluminescence spectroscopy, and Raman spectroscopy will be used to determine surface morphology, structural properties, surface topography and roughness, transmittance and absorbance properties, optical defect, and crystallinity of the nanorod arrays, respectively. For photoresponse characterization of hierarchically homogenous branched, nanopore-enhanced ZnO nanorod arrays, the ultraviolet photoresponse measurement system will be used. This research will contribute to a new and promising nanomaterials fabrication, which suitable for high performance nanodevice applications.

Summary of Research Findings

The effects of deposition speed on properties of zinc oxide (ZnO) nanoparticle decorated ZnO nanorod arrays were investigated. The ZnO nanoparticles were deposited onto ZnO nanorod arrays at various speed from 1000 to 3000 rpm. The result shows that the nanorod were successfully coated with ZnO nanoparticles with good uniformity. This work was a first step toward the optimization of three-dimensional branched ZnO nanorod arrays growth.

Problems/Constrains if Any

none

Recommendation By Project Leader

Overview

Project Title

Fabrication of Novel Hierarchical Homogenous Nanoarchitectures of Branched, Nanopore-Enhanced Nanorod Arrays and Their Photoresponse Characteristics

Progress Report Details

Report Number	Submission Date	Project Completion Rate	Status

Selected Grant

FRGS 2015-1

Cluster

Main Cluster	Sub Cluster
Technology and Engineering	Electrical and Electronic

Project Duration

Start	End
02/11/2015	31/10/2017

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Overall Contribution	Status
22531	Mohamad Hafiz Bin Mamat	811014115415	UITM	Faculty of Electrical Engineering		0 Hours (0.00%)	Project Leader
19858	Mohamad Rusop Mahmood	640202035021				0 Hours (0.00%)	Member
19860	Nafarizal Bin Nayan	791230095089				0 Hours (0.00%)	Member
18622	Noorsaadah Abd Rahman	611106015458				0 Hours (0.00%)	Member
13641	Suriani Abu Bakar	800927045438	UPSI	Faculty of Science and Mathematics		0 Hours (0.00%)	Member
22681	Musa Bin Mohamed Zahidi	810609085337	UITM	Faculty of Electrical Engineering	Lecturer	0 Hours (0.00%)	Member
22812	Mohd Khairul Ahmad	790319045075	UTHM	MiNT-SRC Shamsuddin Research Center		0 Hours (0.00%)	Member
12226	Uda bin Hashim	640330025389	UNIMAP	Institute of Nano Electronic Engineering	Professor	0 Hours (0.00%)	Member
17604	AHMAD SHUHAIMI BIN ABU BAKAR	811003115145	UM	FAKULTI SAINS		0 Hours (0.00%)	Member
16607	SAADAH BINTI ABDUL RAHMAN	560623085510	UM	FAKULTI SAINS	Professor	0 Hours (0.00%)	Member
24720	Azmi Mohamed	810809035051	UPSI	Faculty of Science and Mathematics		0 Hours (0.00%)	Member
47294	Ahmad Sabirin Bin Zoolfakar	780820145003	UITM	Faculty of Electrical Engineering		0 Hours (0.00%)	Member

Executive Summary

Novel hierarchical homogenous nanoarchitectures of branched, nanopore-enhanced nanorod arrays are promising nanostructures for nanosensors and solar cells due to their advantages; that are very high surface area, enhanced light absorbability, and multiple transportation channels of electron. These new nanostructures are anticipated to significantly improve nanodevice's performance in terms of sensitivity, reliability, and functionality. Conventionally, nanorod arrays or branched nanorods with disorder arrangement have been fabricated, but their characteristics (i.e., optical and electrical) and photoresponse properties were highly modulated by surface area availability and arrangement of nanostructures on the substrate. Hence, it is important to increase the surface area of well-arranged or well-aligned nanorod arrays, by tailoring their surface condition to be facilitated with hierarchical branches and nanopores. To the best of our knowledge, the development of hierarchically homogenous branched, nanopore-enhanced nanorod arrays has not been reported yet. The nanoscaled modifications on nanorod array structures, particularly with formation of nanorod branches and nanopores, will provide new insight into characteristics and photoresponse properties of the nanorod arrays. In this research, hierarchically homogenous branched, nanopore-enhanced zinc oxide (ZnO) nanorod arrays will be fabricated using sonochemical approaches. With variations of fabrication parameter, such as ultrasonic power and ultrasonic irradiation time, the photoresponse performance and characteristics (i.e., optical, structural, and electrical) of the prepared nanostructures will be thoroughly investigated. For the characterization purposes, field-emission scanning electron microscopy, transmission electron microscopy, atomic force microscopy, ultraviolet-visible-near-infrared spectroscopy, photoluminescence spectroscopy, and Raman spectroscopy will be used to determine surface morphology, structural properties, surface topography and roughness, transmittance and absorbance properties, optical defect, and crystallinity of the nanorod arrays, respectively. For photoresponse characterization of hierarchically homogenous branched, nanopore-enhanced ZnO nanorod arrays, the ultraviolet photoresponse measurement system will be used. This research will contribute to a new and promising nanomaterials fabrication, which suitable for high performance nanodevice applications.

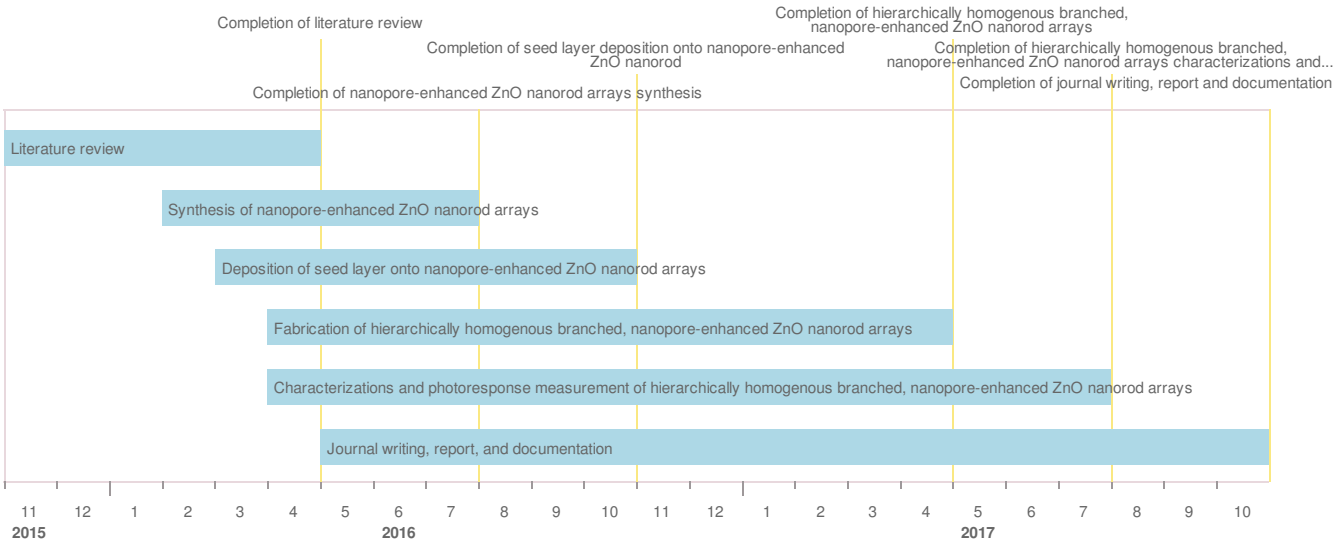
Finance

Legend
Blue :Allocated Budget
Red :Used Budget
Green :Balance Budget

Description	Year 1	Year 2	Total
Vote 11000 - Salary and Wages	21600 15483 6117	21600 0 21600	43200 15483 27717
graduated research assistant wages = RM1800/month	21600 (15483) 6117	21600 (0) 21600	43200 15483 27717
Vote 21000 - Travelling and Transportation	5000 0 5000	5000 0 5000	10000 0 10000
Conference, Seminar, and workshop	2500 (0) 2500	2500 (0) 2500	5000 0 5000
	0 (0) 0	0 (0) 0	0 0 0
	0	0	0

	(0) 0	(0) 0	0 0
Conference, Seminar, and workshop	2500 (0) 2500	2500 (0) 2500	5000 0 5000
	0 (0) 0	0 (0) 0	0 0 0
Vote 24000 - Rental	7160 4660 2500	2500 0 2500	9660 4660 5000
TEM measurement	1000 (0) 1000	2000 (0) 2000	3000 0 3000
XRD measurement	500 (0) 500	500 (0) 500	1000 0 1000
XPS Measurement	1000 (0) 1000	0 (0) 0	1000 0 1000
Research Service (IRMI)	4660 (4660) 0	0 (0) 0	4660 4660 0
Vote 27000 - Research Materials and Supplies	13000 13000 0	7000 7000 0	20000 20000 0
(a)Chemicals (1. Zinc Acetate, 2. Monoethanolamine (MEA), 3. Zinc chloride, 4. 2-methoxyethanol, 5. Zinc nitrate, 6. Hexamethelynetetramine (HMT), 7. Aluminium Nitrate, 8. Polyvinyl alcohol (PVA), 9. Acetone, 10. Methanol, 11. Oxygen gas, 12. Nitrogen gas, 13. Argon gas, 14. polyethelene (PE), 15. PMMA, 16. Tin chloride, 17. Hydrofluoric acid (HF), 18. Al wire, 19. Gold target, 20. Pt target, 21. Pd target, 22. Gold wire, and 23. Ag wire)	7000 (7000) 0	3000 (3000) 0	10000 10000 0
(b)Substrates (1. Silicon wafer, 2. Glass substrate, and 3. ITO-coated glass substrate)	3000 (3000) 0	2000 (2000) 0	5000 5000 0
(c)Consumable Apparatus (1. Sample case, 2. Beaker, 3. Magnetic Stirrer, 4. Pipet, 5. Schott Bottles, 6. Kapton tape, and 7. Physical mask)	3000 (3000) 0	2000 (2000) 0	5000 5000 0
Vote 28000 - Maintenance and Minor Repair Services	0 0 0	0 0 0	0 0 0
	0 (0) 0	0 (0) 0	0 0 0
Vote 29000 - Professional Services	2500 604 1896	2500 0 2500	5000 604 4396
Journal Publication, Conference Fee, and Processing Fees	2500 (604) 1896	2500 (0) 2500	5000 604 4396
	0 (0) 0	0 (0) 0	0 0 0
Vote 35000 - Accessories and Equipment	5340 0 5340	0 0 0	5340 0 5340
Mass flow controller (MFC)	5340 (0) 5340	0 (0) 0	5340 0 5340
Grand Total	54600 33747 20853	38600 7000 31600	93200 40747 52453

Research Activity



Literature review

Date	Planned	Actual
Start	02/11/2015	
End	30/04/2016	

Description

Sub Activities

No.	Person In Charge	Start Date	Description	Expected Man Hours	Actual Man Hours Used	Percentage

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Contribution

Attachments

Synthesis of nanopore-enhanced ZnO nanorod arrays

Date	Planned	Actual
Start	01/02/2016	
End	31/07/2016	

Description

Sub Activities

No.	Person In Charge	Start Date	Description	Expected Man Hours	Actual Man Hours Used	Percentage

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Contribution

Attachments

Deposition of seed layer onto nanopore-enhanced ZnO nanorod arrays

Date	Planned	Actual
Start	01/03/2016	
End	31/10/2016	

Description

Sub Activities

No.	Person In Charge	Start Date	Description	Expected Man Hours	Actual Man Hours Used	Percentage

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Contribution

Attachments	

Fabrication of hierarchically homogenous branched, nanopore-enhanced ZnO nanorod arrays

Date	Planned	Actual
Start	01/04/2016	
End	30/04/2017	

Description

Sub Activities

No.	Person In Charge	Start Date	Description	Expected Man Hours	Actual Man Hours Used	Percentage

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Contribution

Attachments	

Characterizations and photoresponse measurement of hierarchically homogenous branched, nanopore-enhanced ZnO nanorod arrays

Date	Planned	Actual
Start	01/04/2016	
End	31/07/2017	

Description

Sub Activities

No.	Person In Charge	Start Date	Description	Expected Man Hours	Actual Man Hours Used	Percentage

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Contribution

Attachments	

Journal writing, report, and documentation

Date	Planned	Actual
Start	01/05/2016	
End	31/10/2017	

Description

Sub Activities

No.	Person In Charge	Start Date	Description	Expected Man Hours	Actual Man Hours Used	Percentage

Members

Researcher ID	Name	IC/Passport Number	University	Faculty/School/Centre/Unit	Position	Contribution

Attachments	

Publication

Effect of oxygen flow rate on the ultraviolet sensing properties of zinc oxide nanocolumn arrays grown by radio frequency magnetron sputtering

Author(s)

Type	Journal Paper
Status	Accepted
ISBN/ISSN	0272-8842
Name of Journal/Publication	Ceramics International
Publisher	Elsevier
Published Year	2016
Volume	42

Issue	3
Pages	4107–4119
Indexing Body	ISI
DOI	http://dx.doi.org/10.1016/j.ceramint.2015.11.083
Acknowledgement	**ceri.pdf**
Front Page	**ceri.pdf**
Attachments	**ceri.pdf**

Fabrication of hierarchical Sn-doped ZnO nanorod arrays through sonicated sol–gel immersion for room temperature, resistive-type humidity sensor applications

Author(s)

Type	Journal Paper
Status	Accepted
ISBN/ISSN	0272-8842
Name of Journal/Publication	Ceramics International
Publisher	Elsevier
Published Year	2016
Volume	42
Issue	8
Pages	9785–9795
Indexing Body	ISI
DOI	doi:10.1016/j.ceramint.2016.03.071
Acknowledgement	**H-ceri2-2.pdf**
Front Page	**H-ceri2-2.pdf**
Attachments	**H-ceri2-2.pdf**

Exhibition

Patent

Product

Human Capital

Human Capital	Number			
	On-Going		Graduated	
Citizen	Malaysian	Non-Malaysian	Malaysian	Non-Malaysian
PhD Student	0	0	0	0
Master Student	1	0	0	0
Summary	Target : 1 Current : 1			

Siti Aishah Binti Saidi

Thesis Title	Fabrication of novel hierarchical homogeneous nanoarchitectures of branched zinc oxide nanorod arrays for humidity sensor applications
Supervisor	**Mohamad Hafiz Bin Mamat**
Type	Master
Citizenship	Malaysia
Year of Graduation	On-Going

Assets